Geophysical Research Abstracts
Vol. 13, EGU2011-12633, 2011
EGU General Assembly 2011

Seismic noise in a geologically complex site (L'Aquila, central Italy) to fine-tune the subsoil model for seismic microzonation mapping

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We present the fine scale investigations of seismic noise carried out in a geologically complex site in the Aterno R. Valley (L'Aquila, central Italy). The goals of the study are to point out the efficiency of seismic noise technique in geologically complex site by comparing those data with other geophysical investigations (active seismic techniques, gravimetric survey) and geological data (more than 60 well logs and a detailed fine scale geological mapping), to fine-tune the subsoil model and to locate the geometry of seismic and geological bedrock.

The study area is located in the western part of L'Aquila intramontane plain which was struck by the recent April 6 earthquake (Mw: 6.3). L'Aquila intramontane plain is a typical Quaternary basin of central Apennines and it is a halfgraben extending in a WNW-ESE direction, along the Aterno River Valley. The carbonate bedrock is variably displaced by normal faults, with both Apennine (NW-SE) and anti-Apennine (NE-SW) directions, and by a N-dipping back-thrust. The alluvial deposits consist of more or less coarse gravels, sands and silty clays of fluvial and alluvial-fan environments organised in lenticular bodies.

The model of subsoil was reconstructed by correlating borehole stratigraphies with data from geophysical tests (down-hole, cross-hole and microtremor measurements).

In the study area the presence of a double amplification peak is the main characteristics of HVNSR data. This feature can be related to the presence of two strong impedance contrasts in the deposits filling the Aterno R. Valley. A first shallow contrast, due to the presence of the gravel layer found in the cross hole data, is responsible for the high frequency (> 10Hz) HVNSR peak, while the deeper contrast between recent sedimentary layers and the limestone, acting as seismic bedrock,k at depth of few tents of meters produces the second peak centered at 3Hz.

The inversion of microtremor data, constrained by stratigraphic logs and seismic in-hole tests (down-hole, cross-hole), made it possible to demarcate zones with constant Vs and to reconstruct the depth of the carbonate (or seismic) bedrock; this depth ranged from 0 to 52 m from ground level. The Vs velocities of the alluvial and slope covers range from 300 m/s to 600 m/s. The Vs velocities in the central sector of the valley exceed 400 m/s; this is due to the occurrence of gravely lenses, which reach their maximum thickness in this sector.

This study is a good example of how the seismic noise could furnish a useful contribution to fine-tune the subsoil model also in geologically complex sites.